TITLE OF THE INVENTION

CHARGED-PARTICLE BEAM WRITER

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is based upon and claims the
benefit of priority from the prior Japanese Patent
Application No. 2002-285542, filed September 30, 2002,
the entire contents of which are incorporated herein by
reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a charged-particle
beam writer used to write a microscopic pattern on
a semiconductor wafer. In this type of apparatus,
a pattern based on, for example, CAD (Computer-Aided
Design) data is formed.

2. Description of the Related Art

In electron beam writers used in the process of
fabricating semiconductor chips, it is important to
increase the throughput. For this reason, a variable-
shaped beam (VSB) strategy or a character projection
strategy has been applied to this type of writer in
recent years (refer to, for example, Jpn. Pat. Appln.
KOKAI Publication No. 2002-237445). The variable-
shaped beam strategy is to produce a beam whose cross
section is rectangular, triangular, or of any other
shape and draw a pattern on a semiconductor specimen
with the produced beam. The character projection

strategy is to prepare character data corresponding to a repetitive pattern on LSI (Large-Scale Integration) and draw a pattern on a semiconductor specimen by combining individual characters.

5   Use of the character projection strategy enables specific characters to be drawn in unison, which increases the drawing speed remarkably. The larger the character size becomes and the more the number of characters included in the drawn pattern is increased,

10   the faster the drawing speed becomes. However, as the character size is made larger, the beam current becomes larger in proportion to the area. This causes a problem: the beam gets blurred on the specimen due to a space-charge effect or a so-called Boersch effect.

15   To prevent the beam current from increasing, it is necessary to lower the current density much more than in the VSB strategy. Changing the current density requires to adjust the electronic optical system, which needs complicated, time-consuming work.

20   To overcome this problem, a scan-projection strategy has been proposed in recent years (refer to, for example, Jpn. Pat. Appln. KOKAI Publication No. 2001-217173). The scan-projection strategy is to scan a plurality of characters formed on an EB

25   (Electron Beam) mask with an electron beam and draw a pattern on the semiconductor specimen. Use of this strategy enables a large pattern to be drawn on

the surface of the specimen without a large increase or decrease in the current density. Furthermore, with this strategy, a character of any size can be formed on the EB mask and the drawing speed will not decrease

5   significantly.

When a character is drawn with an electron beam, dimensional errors occur due to a proximity effect or such a phenomenon as fogging. In the scan-projection strategy, dimensional errors can be corrected by

10   dividing each character into a plurality of elements, transferring them, and changing the irradiation time of the beam from one divided element to another. The effective dose of the electron beam applied to each character is influenced by its surrounding characters

15   or the drawing pattern. That is, there is little sense in determining the dose for each divided element, taking only each character in account. Instead, taking into account comprehensively the positions and sizes of a plurality of characters arranged in the drawing

20   pattern, it is necessary to determine the distribution of the dose for the scanning position on a character basis. At present, however, no consideration has been given to what dose distribution is given to which pattern on the specimen (that is, what dose is given to

25   the scanning position).

As described above, in the existing techniques, measures to correct the dose of beam for a position on

the surface of the specimen taking the character

distribution on the pattern into account have not been

adopted. Therefore, it is impossible to optimize the

dose distribution for each character and, therefore,

5   the drawing dimensions of each character are difficult

to correct sufficiently. Consequently, there is

a possibility that the drawing accuracy will decrease.

This disadvantage may be encountered not only with

an electron beam writer but also with an ion beam

10   drawer.

BRIEF SUMMARY OF THE INVENTION

An object of the present invention is to provide

a charged-particle beam writer which causes the best

dose distribution to be given for each character and

15   the drawing dimensions to be corrected suitably and

thereby improves the drawing accuracy.

According to an aspect of the present invention,

there is provided a charged-particle beam writer which

draws a pattern on a specimen with a charged-particle

20   beam generated from a single particle generator by both

of a VSB (variable-shaped beam) strategy and a scan-

projection strategy, the charged-particle beam writer

comprising: a data creating unit configured to create

pattern data representing a state where a first-type

25   figure drawn by the VSB strategy and a second-type

figure drawn by the scan-projection strategy are

arranged on the specimen; a computing unit configured

to calculate, on the basis of the pattern data, the amount of correction for correcting the drawing dimensions of the first-type figure on the specimen and the drawing dimensions of the second-type figure on the specimen; and a control unit configured to control the dose of beam at each position on the specimen on the basis of the calculated amount of correction.

With the present invention, data corresponding to a character pattern (and data for drawing by the VSB strategy) is expanded on a specimen. On the basis of the expanded data obtained from the expansion, the optimum dose distribution at each position on the specimen is determined. According to the dose distribution, drawing is done by the scan-projection strategy. Specifically, the irradiation time of the charged-particle beam or the current density is changed at each position of the beam scanning, which causes the beam dose density to have a distribution in the same character pattern. This makes it possible to do drawing with the optimum dose of beam in the character pattern and further correct the amount of correction accurately for the correction of dimensional errors, such as the correction of a proximity effect.

Additional objects and advantages of the invention will be set forth in the description which follows, and in part will be obvious from the description, or may be learned by practice of the invention. The objects and

advantages of the invention may be realized and obtained by means of the instrumentalities and combinations particularly pointed out hereinafter.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention, and together with the general description given above and the detailed description of the embodiments given below, serve to explain the principles of the invention.

FIG. 1 shows the configuration of the optical system of an electron beam writer according to an embodiment of the present invention;

FIG. 2 is a plan view of the EB mask 18 in FIG. 1;

FIG. 3 is a functional block diagram of the electron beam writer of an embodiment of the present invention;

FIG. 4 shows an example of broken-down character data;

FIG. 5 shows the structure of EB mask data. In a memory 310a of the deflection control unit 310, data related to the EB mask 18 is stored in advance;

FIG. 6 shows a data structure of a pattern drawn by the scan-projection strategy;

FIG. 7 shows another data structure of a pattern drawn by the scan-projection strategy;

FIG. 8 shows an example of the data structure of

the dose table;

FIG. 9 shows how the scanning position on the surface of the specimen corresponds to the dose table; and

5   FIG. 10 shows a state where a certain shot is defined by character data and VSB data redundantly.

DETAILED DESCRIPTION OF THE INVENTION

FIG. 1 shows the configuration of the optical system of an electron beam writer according to an
10   embodiment of the present invention. In FIG. 1, numeral 11 indicates an electron gun (hereinafter, referred to as a gun 11) that produces an electron beam. Numeral 12 indicates a blanking deflector for providing on/off control of an electron beam. Numeral
15   13 indicates a shaping deflector for shaping a beam and selecting a character. Numeral 14 denotes a main objective deflector. Numeral 15 shows a sub-objective deflector. Numeral 16 indicates a blanking aperture mask. Numeral 17 shows a first shaping aperture mask
20   with a rectangular aperture. Numeral 18 denotes a second shaping aperture mask with a plurality of apertures. Numeral 19 denotes a specimen. Numeral 20 shows a specimen stage. Numerals 21 to 24 indicate various types of lens systems.

25   An electron beam emitted from the gun 11 is projected onto the first shaping aperture mask 17 (hereinafter, referred to as the EB mask 17) via the

blanking aperture 16. The aperture image of the EB mask 17 is formed on the second shaping aperture mask 18 (hereinafter, referred to as the EB mask 18). The image on the EB mask is formed on the specimen 19.

FIG. 2 is a plan view of the EB mask 18 in FIG. 1. As shown in FIG. 2, the EB mask 18 has a polygonal aperture 201 for producing a variable-shaped beam and a plurality of character apertures 202 composed of various characters. When the shaping deflector 13 has selected the polygonal aperture 201, the rectangular aperture formed by the EB mask 17 and the polygonal aperture 201 are overlapped with each other optically, which produces a rectangular or triangular beam. In this case, drawing is done by the variable-shaped beam strategy.

When the shaping deflector 13 has selected any one of the character apertures 202, the beam is scanned across the selected character aperture 202, which transfers the image of the character aperture 202 onto the specimen 19. In this case, drawing is done by the scan-projection strategy.

In the explanation, the shaping deflector 13 has the function of selecting either the polygonal aperture 201 or any one of the character apertures 202 and the function of scanning the beam. Instead of this, the aperture 201 and any one of the character apertures 202 may be selected by separate deflectors.

Furthermore, to scan the beam across the aperture 202, a higher-speed deflector may be provided additionally.

FIG. 3 is a functional block diagram of the electron beam writer of the embodiment. In FIG. 3, a data conversion computer 301 gives CAD data to a data processing computer 302. The data processing computer 302 outputs the compressed data about a drawing pattern in a specific region on the surface of the specimen. The compressed drawing pattern data is decompressed by a character data arrangement unit 303. The character data arrangement unit 303 breaks down the data of the decompressed data into data items, including character codes (showing the kinds of characters), positions on the specimen, and length and breadth.

Characters to be drawn with VSB strategy are classified into one of a trapezoid and a parallelogram. In the trapezoid, its interior angle may include a right angle. Characters are further classified according to direction. A character code is given to each of the classified characters. A triangle and a rectangle are both classified as special cases of a trapezoid. For example, trapezoids are classified into eight kinds by combining two sides (the upper and the lower sides) and four rotation angles (rotation at intervals of 90°). Parallelograms are classified into eight kinds by combining two kinds in a mirror image reversal relationship and four rotation angles

(rotation at intervals of 90°). Individual characters are classified by character codes distinguished in 16 ways (for example, distinguished by number 1 to number 16). Character codes 22 and later are allocated

5 to the character drawn by the scan-projection strategy. The characters drawn by the scan-projection strategy are expanded into a scan pitch (px, py) related to a scanning process, the number of scans (Nscan), and deflection data (X, Y) on the specimen. A pattern

10 division unit 304 breaks down the character data about the pattern to be drawn by the VSB strategy into five types of character code data showing the kinds of variable-shaped beam, data about the dimensions of the beam, and data about positions on the specimen.

15 FIG. 4 shows an example of broken-down character data. Character codes 17 to 21 are allocated to the characters drawn by the VSB strategy. The character codes 17 to 21 correspond to one rectangular beam and four kinds of isosceles right triangle beam.

20 A proximity effect correction unit 305 calculates the amount of correction for proximity effect correction on the basis of the data created by the character data arrangement unit 303. A dose calculation unit 306 determines the dose of beam on the

25 base of the calculated amount of correction. This process will be explained in detail later.

The output of the dose calculation unit 306 is

sent to a deflection control unit 310. The deflection

control unit 310 controls a blanking amplifier 311,

a character selection deflection amplifier 312,

a shaping deflection amplifier 313, a mask stage

5   control unit 314, an objective deflection amplifier

316, and a specimen stage control unit 318.

The blanking amplifier 311 drives the blanking

deflector 12. The character selection deflection

amplifier 312 and shaping deflection amplifier 313

10   drive the shaping deflector 13. Here deflector 13

consists of two sets of deflection electrodes,

for example. One is for character selection and

another is for beam shaping. The shaping deflection

amplifier 313 is used to obtain a variable-shaped beam.

15   The character selection deflection amplifier 312 is

used to select a character.

The mask stage control unit 314 drives a mask

stage 317 on which an EB mask 18 is placed. The

position of the mask stage 317 is measured by a laser

20   interferometer 315. The measurement information is

given to the mask stage control unit 314. The mask

stage control unit 314 provides feedback control of the

position of the mask stage 317. The objective

deflection amplifier 316 drives the deflectors 14, 15.

25   The specimen stage control unit 318 drives the

specimen stage 20 on which the specimen 19 is placed.

The movement of the specimen stage 20 is measured by

the laser interferometer 319. The measurement
information is given to the specimen stage control
unit 318. The specimen stage control unit 318 provides
feedback control of the position of the specimen

5   stage 317.

Next, a method of drawing a pattern in the
apparatus shown in FIG. 3 will be explained.
Hereinafter, a method of correcting the dose of beam in
drawing a pattern on the surface of a specimen by using

10   both of the VSB strategy and the scan-projection
strategy will be explained in detail.

When drawing a character on the surface of a
specimen by the VSB strategy, the deflection control
unit 310 shapes an electron beam by use of a variable

15   shaping pattern (polygonal aperture) 201 on the EB
mask 18 and then projects the shaped beam onto
the specimen 19. When drawing a character by the
scan-projection strategy, the deflection control
unit 310 selects any one of the character apertures 202

20   on the EB mask 18 and scans the electron beam across
the selected character aperture 202, thereby
transferring the pattern onto the specimen 19.

FIG. 5 shows the structure of EB mask data.
In a memory 310a of the deflection control unit 310,

25   data related to the EB mask 18 is stored in advance.
The data is represented by, for example, a structure
shown in FIG. 5. In FIG. 5, an EB mask code is caused

to correspond to each address in the memory 310a.
Each EB mask code includes the block position
coordinates (XB, YB) of the character corresponding to
the mask code in the EB mask 18 and the relative

5   position coordinates (XF, YF) of the character in the
block. On such data, the amount of deflection of the
electron beam on the EB mask 18 is determined. In
addition, for each character to be transferred, the
pitch of the character, the number of scans, and the

10   dose are determined. On the basis of the determined
values, the character pattern is transferred onto the
specimen 19.

When a character to be transferred is outside
a shaping deflection region, the EB mask stage 317 is

15   moved so that the character may be included in the
shaping deflection region.

FIG. 6 shows a data structure of a pattern drawn
by the scan-projection strategy. In FIG. 6, a pattern
is divided into latticed sub-regions. The pattern

20   density in each sub-region or information about the
size and position of a representative character is
caused to correspond to the coordinates on each EB
mask 18. In addition, the total area S of the
characters included in the pattern and the x-coordinate

25   xG and y-coordinate yG of the center of gravity are
caused to correspond to the coordinates on each EB
mask 18. To simplify the explanation below, pattern

density information is used.

The data processing computer 302 to proximity
effect correction unit 305 carry out the process of
breaking down characters and the process of making
5   a correction to dimensional error factors (for example,
proximity effect correction) and determines the optimum
value of the dose of electron beam for each region.
The dose is calculated on the basis of the pattern
density distribution in each region. When a writer
10   with an acceleration voltage of 50 keV is used, suppose
a rectangular region is obtained by adding, for
example, a 20-μm-wide region to the periphery of the
rectangular region whose dose is to be calculated.
The region is divided into sub-regions, each about 1 by
15   1 micrometers square. Next, the area where the pattern
drawn by the VSB strategy belongs to each small region
is determined, thereby forming a table that causes the
areas to correspond to the corresponding patterns.
Next, the area where the pattern is included in each
20   small region is added to the table on the basis of the
pattern area density related to the pattern data drawn
by scanning.

The division regions of the data related to the
scanning pattern do not necessarily coincide with the
25   small regions. To overcome this problem, the data
related to the scanning pattern is divided in units of,
for example, 0.25 μm and the data is distributed on

the basis of the areas where the division regions
and the small regions overlap with one another.
The pattern data included in the EB mask is stored in
a memory (not shown) of the data processing computer
302 before drawing.

The format of the character data can be considered
as follows. For example, a pattern to be transferred
to an area of 20 μm^2 on the specimen is divided into
0.25 μm-lattice sub-regions, which creates data about
the pattern area included in nx $\times$ ny = 80 $\times$ 80 = 6400
lattices when px = py = 0.25 μm. This data is stored
in the memory so as to follow the address in which the
character data is included.

FIG. 7 shows another data structure of a pattern
drawn by the scan-projection strategy. The data format
shown in FIG. 7 is such that each pattern is classified
by the character included in the pattern and the number
of characters n and their arrangement are shown for
each pattern. The arrangement of the characters is
defined by specifying the cardinal coordinates (x0, y0)
of each of the character, the repetitive number of each
of the character (nx, ny), and the pitch of each of the
character (px, py).

The size of each character is made smaller than
the small region 1 by 1 micrometers square. With the
characters included in the pattern data placed on the
specimen, the area data items are added to the small

regions including the characters. When one character extends over different small regions, the data items are distributed to the individual small regions on the basis of the character area and the position of the center of gravity.

By the above processes, the whole data about the pattern area density distribution in each region is obtained. Next, on the basis of the obtained pattern area density, the dose for proximity effect correction is calculated. To do a corrective calculation, various known method may be used. For example, the method disclosed in Jpn. Pat. Appln. KOKAI Publication No. 9-289164 may be used.

FIG. 8 shows an example of the data structure of the dose table. In FIG. 8, (Nx, Ny) shows the number of the small regions included in the dose table. And (px, py) shows the pitch of the small regions included in the dose table. The results of corrective calculations are stored in the dose table as shown in FIG. 8. The dose table is a table that shows the dose for each small region. Data about the whole surface of the specimen may be stored in one dose table. Alternatively, data about a narrow region including the region currently being drawn may be stored in one dose table, which enables the memory to be saved.

When drawing is done, the dose is determined from the coordinates shown in the drawing data string and

the result of the corrective calculation. In the VSB
strategy, the coordinates on the surface of the
specimen is caused to correspond to the dose table.
Then, drawing is done with the dose given to the

5 corresponding small region. The dose is discontinuous
between adjacent small regions. Thus, in actual
drawing, the dose is defined, centering on a small
region. Then, the dose for another drawing point is
determined by interpolating the doses for four adjacent

10 small regions.

FIG. 9, which shows how the scanning position on
the surface of the specimen corresponds to the dose
table, shows a case where a pattern is drawn on the
surface of the specimen by the scan-projection

15 strategy. In FIG. 9, to simplify the explanation,
suppose the scanning pitch is equal to the pitch of
data in the dose table.

On the beam position (Xc, Yc) on the pattern
obtained by scanning, an address in the dose table is

20 determined. From the address, the dose is determined.
When (Px, Py) differs from the pitch of data in the
dose table or when the lattice points where the dose
table is defined slips relative to the lattice points
of beam scanning, the points given in the form of $(Xc,$

25 $Yc)$ may not coincide with the lattice points in the
dose table. In this case, the dose is determined by
interpolation. Furthermore, a small table for scanning

may be obtained in advance from the dose table. Then, the dose may be determined using the small table, which speeds up the reading of the dose.

In the scan-projection strategy, multiple scanning may be done. When multiple scanning is done, the dose is changed according to the degree of multiple. For example, when scanning is done four times, if the dose obtained from the dose table is D0, a first to a third dose D1 to D3 are set to D0/4 and a fourth dose D4 is determined using the equation D4 = D0 − (D1 + D2 + D3). The reason why the way of determining D4 differs from the way of determining D1 to D3 is to decrease the influence of the omission of the characters below specific decimal places in calculations.

When the point where the dose is determined is shifted every scanning in multiple scanning, the dose is determined as follows. Let the dose obtained at the lattice point (i, j) from the dose table be Dij, any of the first to third dose D1ij to D3ij be equal to Dij/4, and the fourth dose D4ij be D4ij = Dij − (D1ij + D2ij + D3ij). As a result, the dose at each point where the dose is to be determined can be determined.

Furthermore, there may be a case where not only a proximity effect but also dimensional fluctuations depending on a much wider pattern area distribution, such as a long-distance exposure effect (fogging effect) or a loading effect, should be corrected.

In such a case, the amount of correction is calculated using data about the whole area of the scan transfer pattern, which enables the calculation efficiency to be increased.   The amount of correction can be calculated

5   by, for example, the method explained below.

First, by combining the correction of a proximity effect and the correction of a fogging effect and a loading effect, the dose density D(x) in each shot is determined so as to meet the following equation (1):

10       $$0.5D(x)(w - \Delta(x))/w + \eta \int \sigma(x - x')D(x')dx'$$
$$+ \theta \int p(x - x')D(x')dx' = 0.5D0 \qquad (1)$$

To facilitate description in equation (1), let both x and x' be two-dimensional vectors.   D0 is a reference dose. η and θ are a parameter representing

15   the influence of a proximity effect and the influence of a long-distance photosensitive action, respectively. $\sigma(x)$ and p(x) are a function of the spread of a proximity effect and a function of the spread of a long-distance photosensitive action, respectively.

20   These are determined in advance experimentally.

$\Delta(x)$ represents a distribution of variations in the dimensions due to the dose (for example, resulting from a loading effect).   Suppose $\Delta(x)$ is constant in a region about 1 by 1 millimeters square.   Generally,

25   the spread of a proximity effect $\sigma(x)$ is about 10 micrometers.   The spread of a long-distance photosensitive action p(x) is about several

millimeters. When the influence of forward scattering is included in the spread of a proximity effect $\sigma(x)$, $\sigma(x)$ represents a distribution with a sharp peak in the middle.

5   The integration range on the left side of equation (1) is the pattern region of the whole mask surface. From the viewpoint of practical use, an integration range in a first integration including $\sigma(x - x')$ may be limited to a region with a radius of about 10 μm

10 having point x in the center. In addition, an integration range in a second integration including $q(x - x')$ may be limited to a region with a radius of about 30 mm having point x in the center.

    To correct a proximity effect and a long-distance

15 photosensitive action, for example, the following method can be considered. If $D(x) = dp(x) \times df(x)$ and if a change in $df(x)$ is gentler than that in $dp(x)$, equation (1) is approximated suitably by the following equation (2):

20 $$0.5dp(x)df(x)\{w - \Delta(x)\}/w$$
$$+ \eta\, df(x) \int \sigma(x - x')dp(x')dx'$$
$$+ \theta \int q(x - x')dp(x')df(x')dx' = 0.5D0 \qquad (2)$$

    $dp(x)$ in equation (2) is determined so as to meet the following equation (3):

25 $$0.5dp(x) + \eta\, w/\{w - \Delta(x)\} \int \sigma(x - x')dp(x')dx'$$
$$= 0.5 \qquad\qquad\qquad\qquad (3)$$

    Under the condition given by equation (3), the

remaining equation will be expressed as the following

equation (4):

$0.5df(x) + \theta w$

$/\{w - \Delta(x)\} \int q(x - x')dp(x')df(x')dx'$

5      $= 0.5w/(w-\Delta(x))D0$ (4)

In the integration included in equation (4), even

if the integration range is 1 by 1 millimeters square

and df(x) is constant in the range, there will be no

large error in the calculations. The integration range

10   is limited to within a region 1 by 1 millimeters

square, the term including the integration in equation

(4) is expressed by the following expression:

$\Sigma q(x - xj)df(xj) \int dp(x')dx'$

In the equation, j is a suffix denoting a region.

15   As seen from the equation, the term including the

integration in equation (4) is expressed by the sum of

the terms including integration with respect to the

individual regions.

When both sides of equation (3) are integrated in

20   a region about 1 by 1 millimeters square, the part of

the integral in the second term is expressed by the

following double integration:

$\int \int \sigma(x - x')dp(x')dx'dx$

This is approximated suitably by the following

25   expression:

$\int dp(x')dx'$

If the domain of integration with respect to x' is

the region 1 by 1 millimeters square, this gives the
following equation:

$$[0.5 + \eta w/\{w - \Delta(x)\}] \int dp(x')dx' = 0.5 \times$$
(pattern area)

That is, $\int dp(x')dx' = 0.5 \times$ (pattern area)$/(0.5 +$
$\eta w/(w - \Delta(x)))$. Therefore, equation (4) is expressed
by the following equation (5) with respect to the
region i:

$$0.5df(xi) + \theta$$

$$/[0.5 + \eta w/\{w - \Delta(x)\}] \Sigma q(xi - xj)df(xj) \times 0.5$$

$$\times \text{(pattern area)} = 0.5w/\{w - \Delta(x)\}D0 \qquad (5)$$

Producing simultaneous equations for the
individual regions on the whole surface of the mask
from equation (5) enables df(xi) to be determined. As
for the region to be scan-transferred, use of the
pattern area previously given as data about the EB mask
makes it possible to increase the efficiency of
calculating the pattern area of each small region.

With the above method, if the parameter
representing the influence of a proximity effect is θ
and the parameter representing the influence of
a long-distance photosensitive action is η, and if
the patern area of each region is known, df(xi) can be
determined without requiring a fine pattern
distribution (generally) needed to correct the
proximity effect.

To summarize what has been described above,

the distribution of df(x) is determined in advance.
The result is stored in memory means or the like.
When drawing is done, dp(x) is calculated with respect
to the vicinity of the drawing region by the
aforementioned method. Then, dp(x) is multiplied by
the value of df(x) of the corresponding region.
As a result, it is possible to calculate the amount of
correction that can correct all of the influence of
a proximity effect, the influence of a long-distance
photosensitive action, and the influence of a loading
effect.

As described above, with the embodiment, when
a pattern is drawn on the surface of a specimen by
using both of the scan-projection strategy and the VSB
strategy, it is possible to determine the optimum dose
of beam after combining the scan transfer pattern data
and the drawing pattern data. As a result, it is
possible to determine the dose of beam accurately by
correcting the proximity effect and the like throughout
the whole region. Accordingly, the optimum dose
distribution is given to the character pattern, thereby
correcting the dimensions of the character pattern,
which improves the drawing accuracy.

The present invention is not limited to the above
embodiment. In the embodiment, an example of using
both of the VSB strategy and the scan-projection
strategy has been explained. The invention may be

applied to a case where the whole region of the surface of the specimen is drawn by the VSB strategy or a case where the whole region is drawn by the scan-projection strategy.

5   Furthermore, the present invention may be applied to a case where the dimensions of a drawing pattern by the scan-projection strategy are not constant. In addition, the invention may be applied to ordinary character projection drawing, provided that the scan

10   pitch is set to one in both of the x direction and the y direction. Moreover, the invention may be applied to a case where a pattern has only to be scanned partially, depending on the pattern, without scanning the entire surface of the character aperture 202.

15   Furthermore, it may be convenient to define a pattern on the surface of a specimen redundantly by using character data and VSB data and create drawing data. This will be explained by reference to FIG. 10.

    FIG. 10 shows a state where a certain shot is

20   defined by character data and VSB data redundantly. A case where such a shot appears will be explained below.

    At rows 21-40 of the VSB pattern data, flag data indicating whether an overlap with another

25   pattern is present, flag data indicating the number of overlaps are added, and outline data about the overlap part are added at rows 41-52. When VSB pattern data is

created, a check is made to see if the pattern to be
drawn is included in the region where the character
data has been defined (for example, the region 20 by
20 micrometers square). Then, if the VSB·pattern data
is found in the region where the character data has
been defined, a check is made to see if there is
an overlap with the character data with respect to
the VSB pattern data.

As a result, if an m number of overlaps have been
found, following the pattern data, data about a point
defining the outline of the overlap part is added.
For the data showing the outline, the number of outline
points, the coordinates of a first outline point, and
the relative coordinates of each outline point with
respect to the first outline point are defined.

Using such data items, drawing is done as follows.
After decompressing the drawing data, the character
data arrangement unit 303 interprets the flag data to
check to see if there is an overlap between patterns.
If there is an overlap between patterns, the character
data arrangement unit 303 creates small pattern data by
removing the overlapping part from the VSB pattern data
and discards the original pattern data including the
overlap. On the basis of the corrected data obtained
as described above, the proximity effect is corrected
and drawing is done.

While in the embodiment, the explanation has been

given taking an electron beam writer as an example, the present invention may be applied to an ion beam writer in a similar manner. Furthermore, this invention may be practiced and embodied in still other ways without departing from the spirit or essential character thereof.